UNMANNED AERIAL VEHICLE TRACKING AND CONTROL

PRIORITY CLAIM

[0001] This application claims benefit of priority to Singapore Application No. 10202002204 W, titled "Unmanned Aerial Vehicle Tracking and Control", filed Mar. 11, 2020, which is hereby incorporated by reference in its entirety as though fully and completely set forth herein.

FIELD

[0002] The invention relates to unmanned aerial vehicles (UAVs), and more particularly to a system and method for tracking and/or controlling of UAVs in a cellular network system.

DESCRIPTION OF THE RELATED ART

[0003] Unmanned aerial vehicles, also referred to as drones, may be characterized as mobile devices or systems that are used for various applications, such as acquiring or sensing information (e.g., video acquisition or surveillance), delivering goods, or other activities. The usage of UAVs has rapidly increased in recent years, in part due to the many applications in which they can be used. For example, UAVs may be utilized to travel to remote, inaccessible, and/or inconvenient locations to perform various actions. In some applications, a UAV is controlled by a human user (e.g., a user on the ground), where the user uses a UAV controller (UAC) to remotely control the operation of the UAV. In some implementations, the UAC may communicate with the UAV over an existing cellular network. One issue that may arise is what information may be required for the existing cellular network to track and/or control the UAV and/or how to track the UAC. Therefore, improvements in the field are desired.

SUMMARY

[0004] Embodiments relate to apparatuses, systems, and methods for tracking and/or controlling unmanned aerial vehicles (UAVs) as well as tracking UAV controllers (UACs) within a cellular network. Embodiments may include various methods for a UAV/UAC to provide a cellular network with tracking information such as speed, orientation, altitude, C2 communication quality, Cell ID, TAC ID, current location of the UAV, and destination of the UAV. The tracking information may be provided either periodically or may be event triggered, e.g., based on certain thresholds obtaining or being met. The network may forward this information to an unmanned aerial system (UAS) traffic management entity (UTM). The UTM may determine, based in part on the tracking information, whether to transfer control of the UAV from the UAC to the UTM. In some embodiments, the UAV/UAC may trigger the UTM to transfer control of the UAV form the UAC to the UTM. For example, a UTM may receive, from a network entity, tracking information associated with the UAV and/or a UAC associated with the UAV, wherein the UAV is in a Network-Assisted control mode, and wherein the tracking information includes at least one of a UAV identifier (UAV ID) associated with the UAV or a UAC identifier (UAC ID) associated with the UAC. The UTM may determine, based on the tracking information associated with the UAV, to switch the UAV from the Network-Assisted control mode to a UTM-Navigated control mode and may send, to the network entity, a control mode change request, wherein the control mode change request includes at least one of the UAV ID or UAC ID.

[0005] As another example, a UAV may send, to a network entity, tracking information associated with the UAV and/or a UAC associated with the UAV, wherein the UAV is in a Network-Assisted control mode, and wherein the tracking information includes at least one of a UAV identifier (UAV ID) associated with the UAV or a UAC identifier (UAC ID) associated with the UAC. The UAV may receive, from the network entity, a control mode change request indicating a switch of the UAV from the Network-Assisted control mode to a UTM-Navigated control mode, wherein the control mode change request includes at least one of the UAV ID or UAC ID. The UAV may send, to the network entity, a control mode change confirmation, wherein the control mode change request includes at least one of the UAV ID or UAC ID.

[0006] As a further example, a UAC associated with a UAV may send, to a network entity, tracking information associated with the UAV and/or the UAC, wherein the UAV is in a Network-Assisted control mode, and wherein the tracking information includes at least one of a UAV identifier (UAV ID) associated with the UAV or a UAC identifier (UAC ID) associated with the UAC. The UAC may receive, from the network entity, a control mode change request indicating a switch of the UAV from the Network-Assisted control mode to a UTM-Navigated control mode, wherein the control mode change request includes at least one of the UAV ID or UAC ID. The UAC may send, to the network entity, a control mode change confirmation, wherein the control mode change request includes at least one of the UAV ID or UAC ID.

[0007] As another example, a network entity may receive, from a UAV and/or a UAC associated with the UAV, tracking information associated with the UAV, wherein the UAV is in a Network-Assisted control mode, and wherein the tracking information includes at least one of a UAV identifier (UAV ID) associated with the UAV or a UAC identifier (UAC ID) associated with the UAC. The network entity may send, to the UTM, the tracking information associated with the UAV and may receive, from the UTM, a control mode change request indicating a switch of the UAV from the Network-Assisted control mode to a UTM-Navigated control mode, wherein the control mode change request includes at least one of the UAV ID or UAC ID. The network entity may send, to the UAV and/or UAC, the control mode change request and may receive, from the UAV and/or UAC, a control mode change confirmation, wherein the control mode change confirmation includes at least one of the UAV ID or UAC ID. The network entity may send, to the UTM, the control mode change confirmation.

[0008] As yet another example, a Third Party Authorized Entity (TPAE) may receive, from a UTM, tracking information associated with the UAV and/or a UAV controller (UAC) associated with the UAV, wherein the UAV is in a Network-Assisted control mode, and wherein the tracking information includes at least one of a UAV identifier (UAV ID) associated with the UAV or a UAC identifier (UAC ID) associated with the UAC. The TPAE may determine, based on the tracking information associated with the UAV, to switch the UAV from the Network-Assisted control mode to a UTM-Navigated control mode and may send, to the UTM,